INTRODUCTION TO ENERGY EFFICIENCY IN SPORTS AND RECREATION CENTRES

BEST PRACTICE PROGRAMME

Energy Efficiency Office
DEPARTMENT OF THE ENVIRONMENT

CONTENTS

1

INTRODUCTION

1.1 Who this guide is intended for

This guide is intended for the managers of sports, recreational, community and leisure centres, swimming pools and sports and fitness clubs. It will also be of interest to energy managers who have such facilities within their responsibility.

It is intended to introduce the steps that anyone responsible for energy needs to take in order to control and reduce energy consumption. It shows how to gain an understanding of energy use and indicates the methods by which savings are likely to be made.

1.2 Use of the guide

This guide is one of a series for different types of building. A full list of titles is given in section 9.3; make sure that you have the guide most suited to your needs.

If you are unfamiliar with energy management, you should start with section 2, Energy Management, in order to get an overview of the subject.

- The subsequent sections concern creating and following an action plan (section 3) and implementing measures to achieve energy savings (section 4). Sections 5 to 7 describe methods for assessing energy use in sports and recreational buildings.
- The case studies (section 8) give examples of sports facilities where energy saving measures have been successfully implemented.
- Section 9 lists further sources of help and information, including addresses for obtaining copies of the information referred to throughout the guide.

More experienced energy managers or consultants may use the action plan (section 3), or the suggested measures (section 4) as aide-memoires. They may also use the method for calculating performance indices described in section 6 and appendix 1.

A manager responsible for energy on a number of different sites may wish to distribute the guide to the person responsible for energy management at each site.

1.3 Environmental benefits of energy efficiency

Most of the energy used today originates from fossil fuels (gas, oil and coal). Burning fossil fuels emits pollutants, including gases that cause acid rain, and carbon dioxide. As carbon dioxide and other gases build up in the atmosphere, more of the sun's heat is trapped (the greenhouse effect). This could result in the earth becoming hotter (global warming), which may also increase the risk of storms, coastal flooding and drought. Using energy more efficiently is one of the most cost effective means of reducing emissions of carbon dioxide and also helps to conserve finite reserves of fossil fuels.

1.4 Financial benefits of energy efficiency

Energy used in sports and recreation buildings costs the nation approximately £600 million each year. Typically energy costs are second only to labour costs and can account for 30% of total operating costs in a sports facility.

Using simple and cost effective measures, fuel bills can often be reduced by about 20%. Further savings are possible in new construction and when buildings are refurbished or their services replaced.

Well designed and efficiently managed services not only result in energy savings, but also in an improved and more comfortable environment for customers and staff. This can give rise to greater satisfaction amongst customers as well as better staff productivity.

Efficiently run buildings also require less manpower to service complaints, providing savings additional to the reduced costs of energy.

1.5 Acknowledgements

This guide was prepared for the Energy Efficiency Office (EEO) by Target Energy Services Ltd. The EEO gratefully acknowledges the assistance given by the following organisations in providing information:

Building Research Energy Conservation Support Unit (BRECSU)

Eastern Leisure Centre, Cardiff

Kirklees Metropolitan Council

London Borough of Hackney

The Sports Council

Welsh School of Architecture

William Bordass Associates

ENERGY MANAGEMENT

2.1 Energy efficiency - a management issue

The aim of energy management is to ensure that energy use and energy costs are as low as possible while standards of comfort and service are maintained or improved. This requires somebody to be directly responsible for energy efficiency, even if this is only a part of their job:

- As a rule of thumb, organisations or sites with an energy bill over £1 million may justify the employment of a full time energy manager. Otherwise, energy management will normally be combined with other responsibilities.
- Each building should have someone responsible for energy management.
- In larger organisations, energy efficiency should also be managed centrally.
- Energy efficiency must be strongly supported at the highest levels with the authority and resources needed for initiatives to be effective.

Encourage your management board to sign up to the EEO's Making a Corporate Commitment campaign if it has not already done so (see section 9.4).

The duties and functions of an energy manager are discussed here. Section 3 includes a suggested action plan which can be used to get things moving.

2.2 Actions and measures to save energy

One of your main activities should be to identify areas of energy waste and implement energy saving measures to reduce them. Some waste is simple to diagnose and to correct, for example lighting left on all night in unoccupied areas. Other waste may be more difficult to identify and take more expertise or resources to correct (see section 4).

2.3 Controlling energy use

To control energy consumption and costs, regular and reliable records of energy use should be maintained. Such records will help to identify changes in energy costs and consumption. This is commonly called monitoring and targeting or M&T. The simplest arrangement is a form which can be filled in regularly for each fuel, recording monthly energy use. Alternatively, systems can be based on a computer spreadsheet, or commercially available systems can be purchased.

Computer based systems are essential for effective monitoring of a large estate or site.

An M&T system should:

- Record energy consumption and any other factors that affect energy use (building usage, weather, productivity, etc).
- Compare your energy use to previous years, to other similar facilities, or to yardsticks representing typical or target energy performance.
- Alert you to sudden changes in energy use patterns as soon as possible, so that any increase can be investigated and corrected if appropriate.
- Produce regular summary reports, especially if there are many sites, to confirm performance and show savings achieved overall.

If fuel bills are not available or some are missing, then duplicates can usually be obtained on request from the relevant fuel supply company.

Meters should be checked every few months to ensure that billed readings are correct. In shared or multi - meter sites ensure you are being billed for your use; label your meters.

For further information see:

EEO Practical Energy Saving Guide For Smaller Businesses.

Example recording of monthly electricity use

Period: *JAN-DEC 92* Completed by: *NJK* Date: *10.2.93*

Meter Reading Date	kWh Used	Cost £
8.1.92	*39,700*	*2756.29*
5.2.92	*38,700*	*2653.65*
5.3.92	*31,500*	*2200.35*
9.4.92	*25,000*	*1584.02*

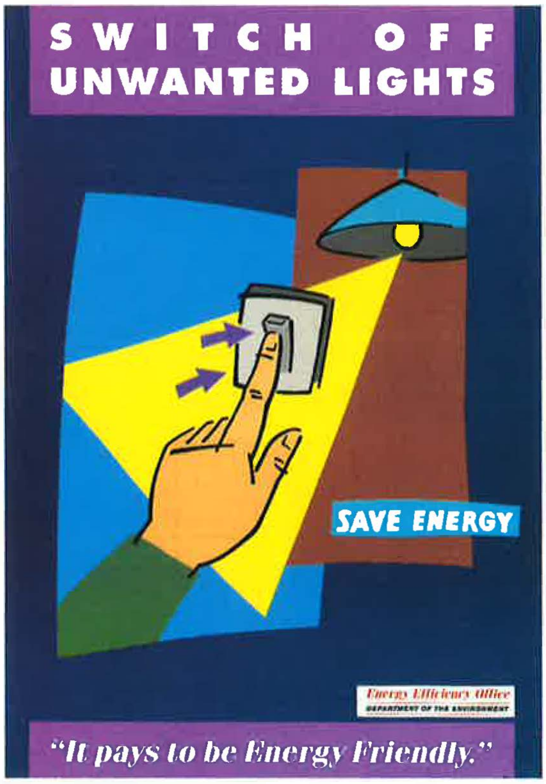
2.4 Getting on the right tariffs

Making sure that fossil fuels and electricity are purchased at the cheapest rates is increasingly important. Considerable cost savings are sometimes possible by changing to more suitable tariffs for electricity, or by making alternative supply arrangements.

Tariff savings usually incur little or no initial cost and may be used to help finance measures to reduce energy costs further. Reviewing tariffs should therefore be one of your first actions:

- Seek alternative electricity tariffs from your existing supplier.
- Consider using other electricity suppliers in the contract market when the supply is for more than 100 kW (representing a bill of around £30,000 a year).
- Consider a different supplier for oil, or for gas supplies over 70,000 kWh a year (representing a bill of around £1,000 a year).
- For large sites with complicated tariffs and load patterns, it may be worth employing a tariff consultant, although be aware of consultants' costs (contact the Energy Systems Trade Association (ESTA) or the Major Energy Users' Council, see section 9.8).

Energy Efficiency Poster



For further information see:

Fuel Efficiency Booklet 9 - Economic use of electricity in buildings.

2.5 Motivating customers and staff

The greatest possible savings can only be achieved with the cooperation of staff. Foster their support and give them every chance to participate in energy saving initiatives. Feed back information to staff on the results of these initiatives.

Activities could include:

- Providing information about why energy conservation is important, describing practical and environmental benefits
- Setting up an incentive scheme
- Stressing that most energy is used by all occupants - for lighting, equipment and for maintaining comfortable conditions
- Encouraging customers and staff to switch off equipment and lighting when it is not needed, by providing information and training on how to operate systems and controls, through stickers, posters and articles in staff magazines
- Linking energy use to the cost of providing the amenities
- Relating energy use at work to energy use at home.

You should monitor the savings achieved and publicise them to help motivate staff and senior management. Obtaining capital investment for future energy efficiency measures may depend on demonstrating the cost effectiveness and the environmental benefits of measures that have already been completed.

For further information see:

EEO Good Practice Guide 84 - Managing and motivating staff to save energy.

2.6 Energy management in larger organisations

In larger organisations with estates of buildings, an energy manager may be responsible for many separate locations. He or she will have a different role from a site energy manager which is not addressed in detail here.

For further information see:

EEO General Information Report 12 - Organisational aspects of energy management

EEO General Information Report 13 - Reviewing energy management

Making a Corporate Commitment - various guides. (see section 9.4).

2.7 Responsibilities in larger facilities

In larger facilities, a number of groups should be involved in energy management:

- Senior management
- Facilities management
- Plant operators
- Security staff
- Local Authority representatives (if appropriate)
- Maintenance contractors.

You should have regular contact with all of the above and with the individual building occupants. A facilities manager often makes a good energy manager because they already have close contact with staff. You should find out about factors relating to occupants' comfort, including:

- How plant and equipment controls are set and who is responsible for their adjustment
- How comments from staff and customers are acted on - especially those reflecting dissatisfaction.

2.8 New and refurbished property

Energy efficiency measures are most cost effective when installed in new or refurbished buildings, or while replacing equipment which is at the end of its normal life. New items of of equipment which are required anyway should be as efficient as possible. Additional items to improve energy efficiency can be installed most cheaply during other building work. These special opportunities to incorporate energy efficient design are relatively rare and should not be missed.

You should be involved in decisions about new or refurbished property and should not just be brought in to correct high energy use following decisions made by others. Your knowledge of how the building is used should be drawn on when specifying appropriate levels of services and controls.

When specifying new or refurbishing sports and recreational facilities, take the opportunity to select or specify:

- Energy targets
- Appropriate environmental conditions for the type of use (avoid over-specifying)
- Systems which are suitably simple and within the capabilities of the occupants to manage
- High efficiency of major plant and equipment such as boilers or main lighting systems
- Good levels of insulation
- Appropriate controls for the anticipated pattern of use
- Suitable metering and monitoring facilities
- Information, advice and training for staff in the use of new systems
- Energy recovery systems (which could include a reverse cycle heat pump in facilities with a swimming pool)
- Combined heat and power systems in swimming pools.

For further information concerning swimming pools see:

EEO Good Practice Guide 56 - Saving energy in school swimming pools. A guide to refurbishment and new pool design.

Refurbishment offers a rare opportunity to incorporate many energy efficiency measures.

2.9 Getting help

Sources of further information are described and listed in section 9.

To obtain further information about possible energy saving measures (see section 4), contact relevant manufacturers, installers or service providers who will advise you of the features of their products. Make sure that these features are relevant and appropriate to your requirements. Gas and electricity suppliers can also offer advice.

If time is not available or if discussions with a selection of competing suppliers do not provide a consistent picture, it may be worth hiring a professional consultant to provide advice or to conduct an energy survey. For organisations with less than 500 employees the EEO's Energy Management Assistance Scheme (EMAS) may offer financial help towards energy consultants' fees (see section 9.4).

If the availability of finance and management time is a problem for opportunities requiring substantial investment, contract energy management (CEM) organisations may provide a solution - they offer a comprehensive service including finance and management responsibility. ESTA can provide a list of companies (see section 9.8).

For further information see:

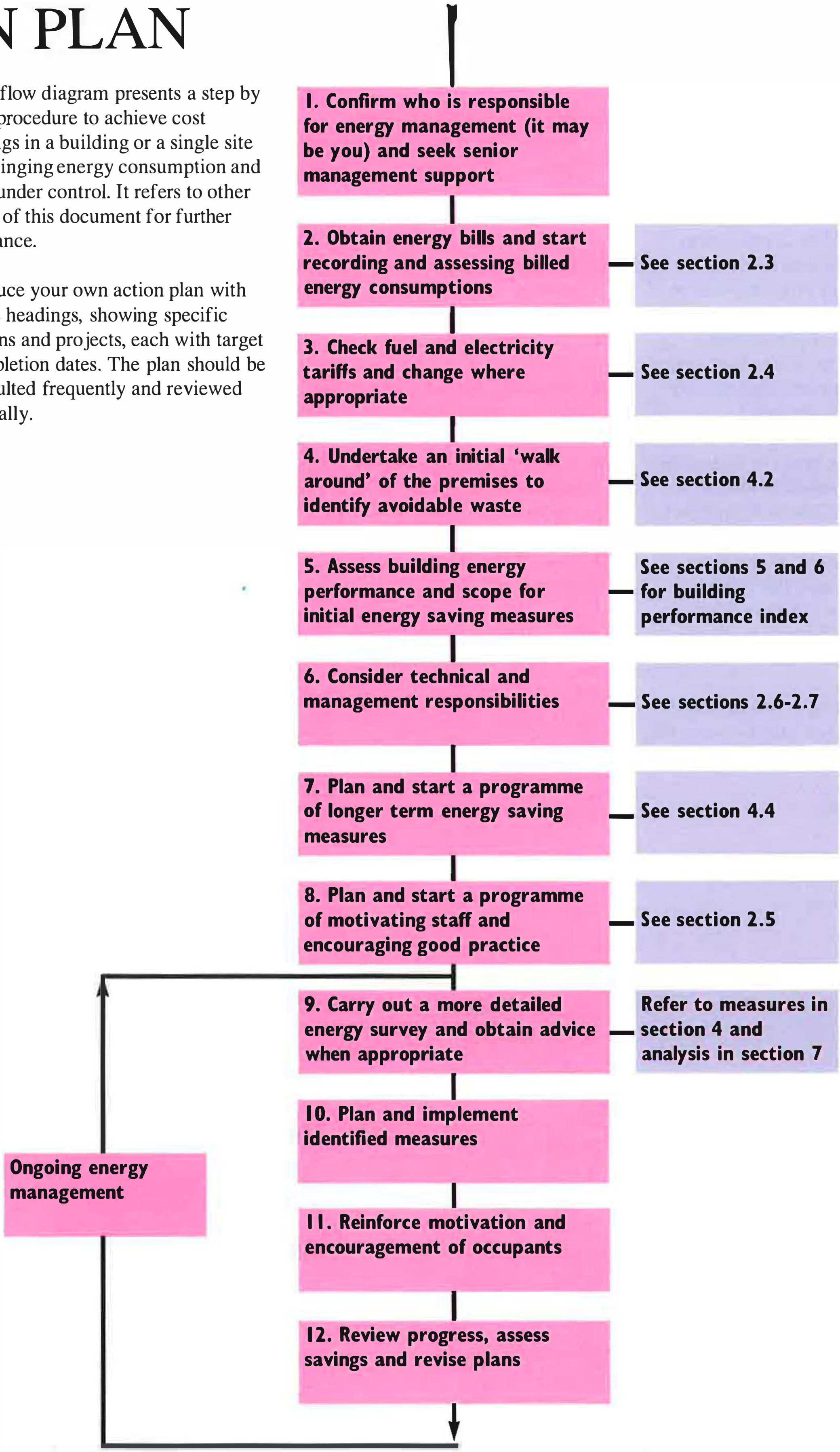
Choosing an Energy Efficiency Consultant (EEO).

3

ACTION PLAN

This flow diagram presents a step by step procedure to achieve cost savings in a building or a single site by bringing energy consumption and cost under control. It refers to other parts of this document for further guidance.

Produce your own action plan with these headings, showing specific actions and projects, each with target completion dates. The plan should be consulted frequently and reviewed annually.



MEASURES TO ACHIEVE ENERGY SAVINGS

4.1 Introduction

Savings in energy use and cost can be achieved through 'good housekeeping' and improvements in standards of fabric and plant efficiency. The main areas for savings, starting with the most cost effective, are:

- Management and control procedures
- Control systems
- Lighting and equipment
- Heating, hot water and ventilation plant
- Building fabric.

Care is required in deciding which measures to implement and the most effective way of carrying them through. In the first instance, measures should be undertaken which have as many of the following features as possible:

- Worthwhile energy and cost savings
- No or low capital cost
- Short period to repay initial cost
- Little technical knowledge required
- Little or no extra maintenance
- Little or no disruption to normal operations.

4.2 Good Housekeeping

In most sports and recreation centres, it is possible to make some savings by using the existing building and equipment as efficiently as possible. No financial investment is needed; instead, a check on how the building is being used may reveal areas where equipment can be turned off when it is not needed, or where the level of service can be reduced without affecting the comfort of customers or staff. In particular, ensure that temperatures are not too high and humidities are not lower than necessary. In swimming pools, make sure that pool covers are used at night.

Some opportunities may be easy to identify and implement, such as altering thermostats or timeclocks. Others, such as turning lights off when rooms are not being used, may require the co-operation of staff and customers. It is worth switching off all lights in any room when it is unoccupied for more than three minutes. Motivating staff to help is therefore important, although a long term task.

Guidance on good housekeeping measures and motivation is contained in other Best Practice publications.

For further information see:

- EEO Good Practice Guide 55 - Good housekeeping in school swimming pools
- EEO Good Practice Guide 129 - Good housekeeping in dry sports centres
- EEO Good Practice Guide 130 - Good housekeeping in swimming pools.

4.3 Maintenance

Regular maintenance is a prerequisite to controlling energy costs and is also essential for maintaining a comfortable environment in sports and recreational buildings and pools. A maintenance programme should include:

- Replace filters at the manufacturer's recommended intervals and keep heat exchanger surfaces, grilles and vents clean in order to allow unobstructed flow of air
- Check plant operation and controls regularly
- Ensure that all motorised valves and dampers fully open and close without sticking
- Check that thermostats and humidistats are accurate
- Check calibration of controls
- Service the boiler plant and check combustion efficiency regularly
- Look for water leaks from mains, taps and showers and carry out repairs where necessary
- Replace 38mm diameter fluorescent tubes in switch start fittings with 26mm diameter high efficiency triphosphor tubes as the former expire (see diagram on page 10)
- Clean lamps and luminaires regularly and replace at the manufacturer's recommended intervals.

For further information see:
EEO Good Practice Guide - Commissioning and maintenance in sports and recreation centres, to be published in 1994.

4.4 Investment in energy efficiency measures

There are many cost effective opportunities for replacing old equipment with new. To identify opportunities, you will need to have some understanding of how energy is used in your sports or recreation facility, and how the required environmental conditions can be maintained most efficiently.

Heating and ventilation

The cost of providing heat for space heating or hot water depends on the cost of the fuel used, the efficiency of conversion of fuel to heat, and the extent of the distribution losses in supplying the heat when and where it is needed.

Fossil fuels such as gas, oil or coal are usually burnt in a boiler and the heat is transferred to a heating system. Boilers have varying seasonal efficiencies - old boilers may convert less than 50% of the energy content of the fuel into heat in the heating system. The most efficient systems include gas condensing boilers and combined heat and power installations (CHP). Condensing boilers can achieve seasonal efficiencies of over 90% and can be used with most existing heating systems, and ought to be considered whenever boilers are replaced.

CHP systems should be considered in facilities with a fairly continuous demand for heat and electricity, and are particularly suited to swimming pools.

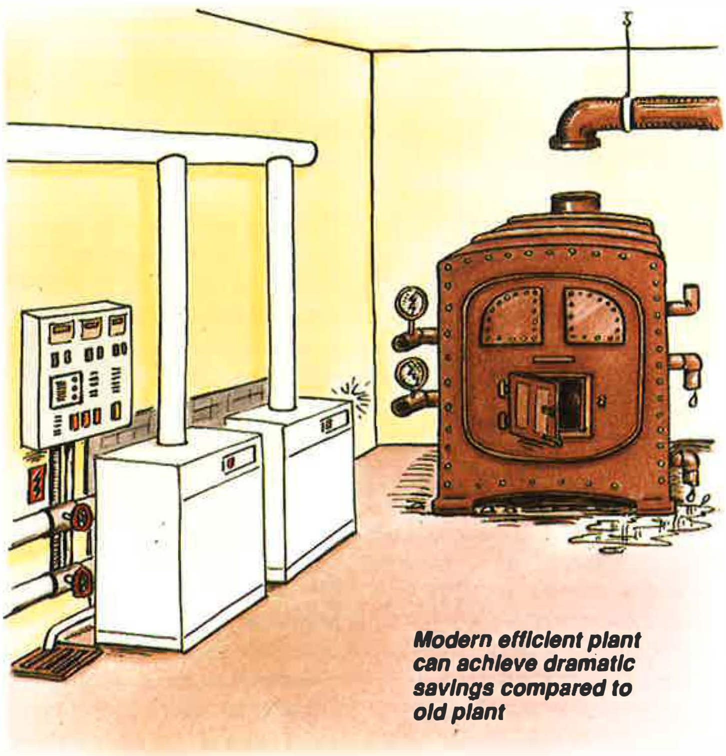
Oversized heating plant leads to low seasonal efficiencies. Systems with multiple boilers maximise seasonal efficiency by allowing the firing boilers to match the heating load.

The most cost effective systems mix CHP, condensing boilers and high efficiency boilers with conventional boilers to optimise capital costs and energy savings.

Heat is lost from the heating system through ductwork, pipework, valves and hot water storage tanks. Pipe runs should therefore be short, and all parts of the system well insulated. Heat should only be supplied to a space or to produce hot water where and when it is needed.

Effective heating controls are essential. Types of control include:

- Simple time control: a time switch that turns heating on and off at a fixed time each day - seven day time switches allow for variable occupancy during the week
- Optimum start control: switches the heating on so that the facility reaches the desired temperature just in time for use
- Weather compensation: varies the heating according to the outside temperature
- Thermostat: maintains the temperature in a space at the required level
- Thermostatic radiator valves (TRVs): regulate the flow of hot water through the radiators in order to maintain a local temperature
- Sequence control: boiler sequence control enables only the number of boilers required to meet the system demand
- Humidity control: used in swimming pool halls to control the ventilation rate and the rate of dehumidification according to the moisture content in the air
- Variable speed controls on pumps and fans: allow motor speeds to be controlled according to the demand instead of running at full power continuously.



Modern efficient plant can achieve dramatic savings compared to old plant

Combined Heat and Power

CHP plant provides both electricity and heat. The fossil fuel supplied to the plant displaces high cost electricity. As the heat which is inevitably produced is used for heating rather than being wasted, it is a more energy efficient means of generating electricity than conventional power stations. Overall efficiencies are typically 60-80 %.

It is essential that the CHP plant is sized correctly in order to maximise the hours it runs and hence the savings achieved. This generally means matching the plant to the base load energy demands in the facility. CHP is usually cost effective if it runs for greater than 4,500 hours/year; this is often the case in facilities with swimming pools.

CHP should be installed under a long term service contract with the supplier. The contract should specify the periods when essential maintenance should take place. It should also include penalty clauses for non compliance to reduce the risk of increased maximum demand tariff charges which would occur when the CHP plant was not running, even for the shortest period. This is particularly important during winter when maximum demand charges are

Luminaires, left to right: recessed mirrored reflector with louvres, batten fittings, opal, and prismatic diffusers.

Photographs supplied by Philips and Fitzgerald.

at their highest. Any prolonged stoppage will also result in an increase in electrical consumption leading to higher overall energy costs.

Building Fabric

Most building fabric measures except simple roof insulation and draught proofing are most cost effective when they form part of general maintenance or refurbishment.

In swimming pool halls, internal insulation can be used to help reduce condensation and thus minimise fabric damage.

Figure 4.1 Typical relative energy consumption

lamp type	typical energy consumption relative to tungsten bulbs for similar levels of lighting (%)
tungsten filament bulb	100
tungsten halogen spotlight	70
compact fluorescent with electronic ballast	18
metal halide (MBI)	15
high pressure sodium	11
Fluorescent tubes:	
(1) choke & starter control gear with 38mm diameter tubes	18
(2) as 1), but 26mm diameter high efficiency triphosphor tubes	16.5
(3) as 2), but with electronic ballast	13

Lighting

Good savings can be achieved by ensuring that lighting equipment and its controls and management are of a high standard.

The energy used for lighting depends upon the energy consumption of the lamps and the hours of use. The most efficient systems are well designed, and have efficient lamps and fittings which provide the required level of illuminance (without over-lighting). They have controls which enable the lights to be switched off when they are not required, whether because a space is not being used or because there is sufficient daylight.

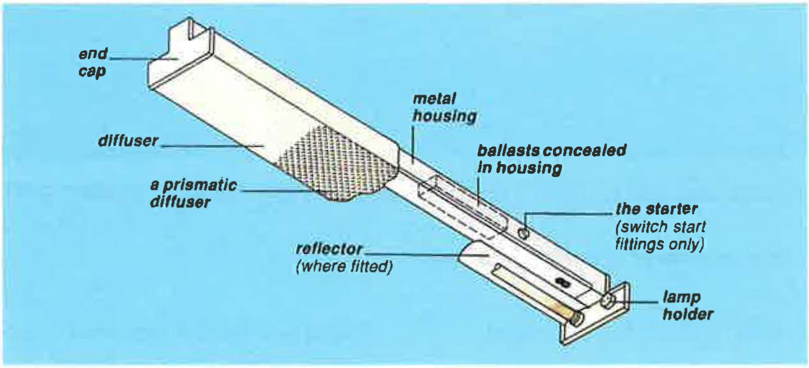
Some types of lamps, in order of increasing efficiency, are:

- 'Domestic' tungsten bulbs - very inefficient; should usually be replaced
- Compact fluorescent lamps - efficient replacements for tungsten bulbs, although not as efficient as modern tubular fluorescent lamps
- Fluorescent tubes - the most energy efficient are triphosphor 26mm tubes

Compact fluorescent lamps

- Sodium discharge lamps - these vary in efficiency, depending on type (most are more efficient than fluorescent tubes), and are ideally suited to sports halls, pools and large outdoor parking areas.

Figure 4.1 shows typical levels of energy consumption of different types of lamp for the same light output, relative to tungsten bulbs. Other aspects of lighting are also important, particularly lighting controls. It should be possible for all lights to be turned off when they are not needed. Automatic controls such as time controls, presence detectors or daylight detectors may be worth using in areas with intermittent use such as games rooms. Card control of lighting and heating for areas with charged facilities such as squash courts are often cost effective.



The parts of a fluorescent light fitting

For further information see:

EEO Good Practice Guide 56 - Saving energy in school swimming pools

EEO Good Practice Guide - Managing energy in sports and recreation centres. A guide for those in control of sports and recreation facilities (to be published in 1994)

EEO Good Practice Guide - Energy efficiency in sports. A technology overview for general managers and local authorities (to be published in 1994).

ENERGY USE IN SPORTS AND RECREATION CENTRES

5.1 Why analyse energy use?

Assessing the energy performance of a building or site allows you to:

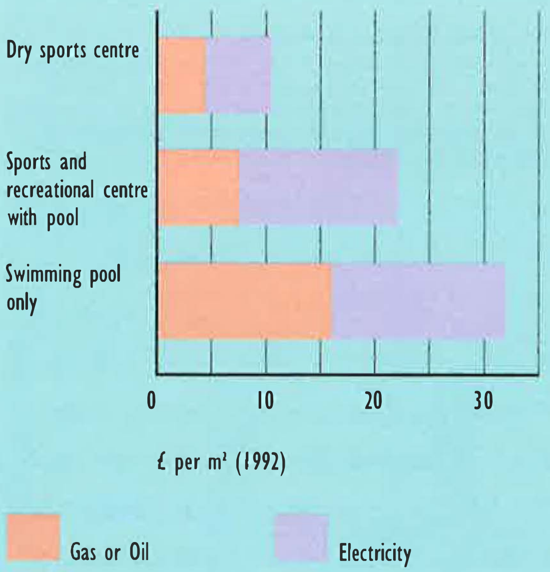
1. Compare performance with standards to suggest the potential for energy saving.
2. Compare with other buildings in an estate or group of buildings to help identify which should be investigated first.
3. Compare with performance in previous years to monitor progress and to assess the effect of any changes or energy saving measures.
4. Consider the energy use in more depth to help understand where energy is used and wasted, and hence where savings are most likely to be made.

A general understanding of what electricity and fuels are used for in different types of building helps to concentrate attention on priority areas, especially where the use of one of the fuels is particularly high.

5.2 Types of sports and recreation facilities and their energy use patterns

Centres come in all shapes and sizes but for clarity this guide defines three common types. Typical energy costs of the three types are given in figure 5.1. Note that the consumptions of energy for different purposes in any one building may be significantly different from the typical breakdowns given here.

Figure 5.1 Typical annual energy costs



Note: Based on total floor area

Dry sports centres

This group covers high street gym clubs for fitness and training, sports clubs which cater for one particular sport such as squash and single multi-use halls.

Electricity is used for lighting with a comparable use for equipment, pumps, fans etc. Fossil energy is used mostly for heating with some consumed in providing hot water for changing rooms.

Sports and recreation centre

Leisure centres provide facilities for a number of sports, sometimes also for recreational activities such as music and drama. A number may also have bars and restaurants located within the centre. Most will include one or more swimming pools within the complex, although if the wet pool area is more than 20% of the total floor area, the centre should be treated as a swimming pool for energy comparison purposes in this guide. Their sizes range from the local recreational complexes to regional and national centres.

Electricity is used for lighting, and for the fans and pumps required for the centre and the pool. Fossil energy is for heating the pool and pool air, and the remainder of the building.

Swimming pools

These are indoor swimming pools which are not part of a sports or recreation centre.

Electricity is used for lighting the pool hall, for ventilation systems and for pumps. Fossil energy is used mainly to heat the pool and the pool hall with smaller use for domestic hot water and for heating the rest of the building.

6

COMPARING WITH ACCEPTED STANDARDS - PERFORMANCE INDICES

6.1 Why use performance indices?

Performance indices give a measure of the energy use of a building which can be compared with yardsticks. They can indicate the potential for improvements and can be used to show progress over time. They can also allow comparisons to be made between buildings in a group or estate.

6.2 Calculating the performance indices of a building and comparing to yardsticks

Two separate indices are calculated for the building, one for electricity and the other for fossil fuels. The separate indices should not be added together, because of the different cost and environmental impact of fossil fuels and electricity.

The performance indices are obtained by dividing the annual building energy use by the floor area. Yardstick values for the different building types are given below, with electricity consumption and fossil fuel energy consumption shown separately.

The procedure is:

1. Enter the annual energy use for each fuel into column 1 of figure 6.1.
2. Multiply each fuel by the conversion factor in column 2 to get common units of energy (kWh is used for electricity and now for gas - conversion units are given in Appendix 2).
3. Enter the gross floor area of the building in column 4.
4. Divide the energy use of each fuel by the floor area to get energy use per unit area (kWh/m²) in column 5.
5. Add the fossil fuel figures together to get a fossil fuel index - the electricity figure can be used directly.
6. Compare the indices with yardsticks for the building type in figure 6.2 to give an energy performance assessment.

Note: this does not take account of the effect of weather on heating energy use (see section 6.4).

There may be exceptional reasons to explain a low or high consumption. For example a building may have a low consumption because part of it is not used, or a high consumption because it has a large restaurant which has not been properly allowed for.

Even a building with a low consumption may have opportunities for cost-effective improvement.

The indices show which fuel requires the most attention. The description of typical energy use patterns in section 5 may help to ascertain which use of energy is most likely to offer potential for savings. Section 4 then outlines possible areas of energy saving for each energy use. The next step is to select and progress suitable measures.

Annual energy consumption of your building.
This is most conveniently obtained from past bills but take care that the figures collected represent a full year and are not "estimated" by the utility. It may be helpful to look at more than one year's bills providing that there have been no significant changes to the building or its use in that time. The numbers you require are the *energy units* consumed, not the money value. Include all fuels: solid fuel, bottled fuel, natural gas, oil and electricity.

Figure 6.1 Energy Performance Index Calculation

		Column 1 Annual Billed Units			Column 2 kWh* Conversion	Column 3 Annual kWh	Column 4 Gross floor area (m²) divide by	Column 5 Annual kWh/m²
Gas			kWh	x	1.0			
Oil type			litres	x				
Other Fossil fuel								
Total of fossil fuel								
Electricity			kWh	x	1.0			

Note * for kWh conversion factors see Appendix 2

6.3 Alternative performance assessment

For buildings in the 'swimming pool only' category a quick first assessment is on a kWh/m² of pool area basis. This is a better assessment if you do not have reliable floor area information.

The two indices are calculated by dividing the facility's annual gas consumption and the annual electricity consumption by the pool surface area. Yardstick values are given in figure 6.2.

In the same way as before a performance assessment is obtained by comparing with yardsticks.

- If your building has unusual occupancy, or experiences unusual weather or exposure you may want to know their likely effect.
- You can compare your building performance with the 'Normalised Performance Indicator' used in previous editions of these guides.
- You may wish to take account of the effect of weather when comparing facilities in different parts of the country.

6.4 Overall yardsticks

Overall yardsticks based on carbon dioxide (CO_2) emissions or the cost of energy per m² of floor area can be used to provide a single performance index. These can be used to prepare league tables which compare groups of buildings or to assess buildings which have fuel supply arrangements which do not fit into the yardstick categories. This may occur, for example, in buildings with electric heating. CO_2 or cost yardsticks are also a better measure of assessment for sites which use combined heat and power (CHP). If the CHP plant provides only a small fraction of the electrical load, the yardsticks given in figure 6.2 will still give a reasonably good assessment. Appendix 1 shows how to apply simple factors for CO_2 emissions or energy cost for each fuel type to calculate an overall performance index.

6.5 Refining the performance indices

If there is more information available, you may wish to assess your performance indices further in a number of ways as described in Appendix 1.

Figure 6.2 Energy Consumption Yardsticks

Performance Assessment

	Low consumption / Medium Consumption: Yardsticks in kWh/m²	Medium Consumption / High consumption: Yardsticks in kWh/m²
	Low consumption Less than → ← **Medium Consumption** Between	→ ← **High consumption** Greater than
Dry sports centre		
Fossil fuels	215	325
Electricity	75	85
Sports and recreation centre with pool		
Fossil fuels	360	540
Electricity	150	205
Swimming pool only		
Fossil fuels	775	1,120
Electricity	165	235
Annual energy use per m² of pool area for swimming pool only		
Fossil fuels	2,950	4,300
Electricity	550	900

7

A CLOSER LOOK AT ENERGY CONSUMPTION

7.1 Introduction

Often a fuller understanding of energy use in a building may be useful, for example after the initial measures have been undertaken, if there is a problem, if the building has poor performance or if it has unexpected energy bills. This section outlines techniques which you may find useful.

7.2 Monthly energy use

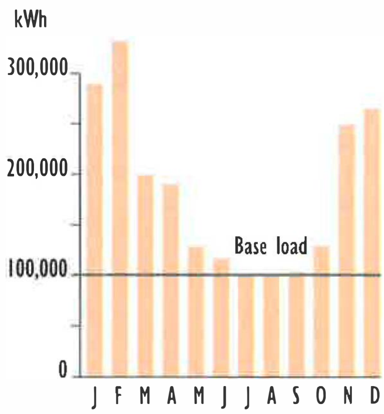
You can ask your supplier for monthly fuel data, or take monthly meter readings yourself.

Larger sites have monthly energy bills. By looking at how these vary with the seasons some valuable insights can be obtained. Produce a monthly consumptions bar chart plot for each energy source over a year.

The billing periods should be checked. If they are not regular, some months will appear unrealistically low and others unrealistically high. This is particularly likely in December and January. If this is the case the average daily consumption for each month can be plotted to give more accuracy.

Fossil fuel consumption, used mainly for heating, should reduce greatly in summer - to zero if it is not being used for other services such as heating a pool, hot water or catering.

Example monthly fossil fuel use for a leisure centre with a swimming pool

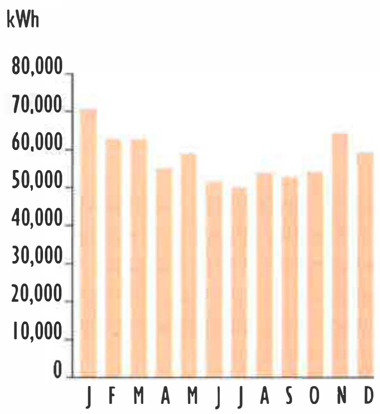


The figure above shows the monthly fossil energy consumption of a sports centre with a swimming pool which has a central boiler system for heating and hot water. The summer usage is lower than winter usage and is at a fairly steady 'base load' level which suggests that the building is not being heated, though it is useful to confirm this by checking that heating pumps are off, and that pipework used solely for heating is cold.

This graph shows a base load, which helps to identify the hot water load, pool heating load and system losses, and the heating load which depends on the weather. In a dry sports centre the base load will be much smaller, comprising system losses and the hot water load.

Electricity consumption should decrease slightly during summer because of lower lighting loads. In an air conditioned building, peaks in spring and autumn may indicate simultaneous heating and cooling.

Example monthly electricity use for a leisure centre with a swimming pool

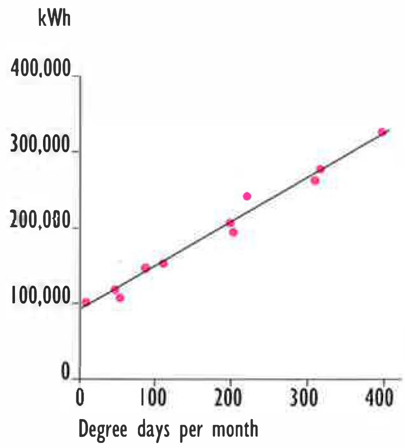


The figure above shows monthly electricity consumption indicating a reduction in summer months. This may be due to reduced use of artificial lighting or possibly there is some electric heating in winter.

7.3 Relating heating use to weather

A fuel that is mainly used for heating should be used more in colder weather. The coldness of the weather can be expressed by a measure known as degree days. This shows by how much and for how long the outside temperature is below a control temperature (usually 15.5°C). Drawing a graph of fossil fuel consumption against the degree days for each month in the year shows how energy consuption is related to weather. Monthly figures for degree days for different areas of the country are published in the EEO's free bimonthly magazine 'Energy Management' (section 9.3).

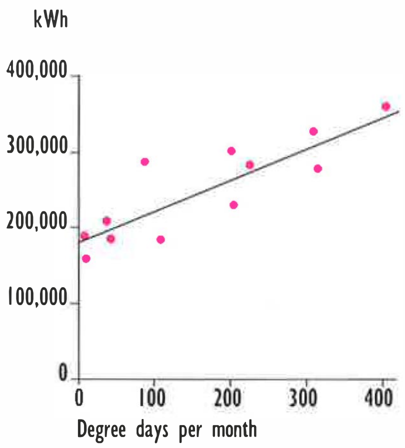
Example monthly heating energy use in a well controlled dry sports centre



The building represented above has a well controlled heating system shown by the close fit of the points to the straight line. As the weather gets colder the energy used goes up proportionally. For this building the energy consumption falls to a small value in summer (low degree day values) when only hot water is being provided.

A building with better insulation would have a less steep slope because energy consumption in winter would be lower.

Example monthly heating energy use in a poorly controlled sports centre with a swimming pool



The figure above has a large scatter of points indicating a building with poor heating control. The energy use in summer is higher (200,000 kWh) than in the previous figure, possibly as a result of the swimming pool heating and ventilation. However, it may also be possible that heating is being used unnecessarily in the summer or that the boiler and hot water systems have high losses which lead to excessive waste.

For further information see:

Fuel Efficiency Booklet 7. Degree Days

7.4 Adjusting energy use for weather

Once you know how weather conditions affect energy use, it is possible to allow for varying conditions. For example, it is possible to take account of the weather when comparing a building energy performance from year to year. Such comparisons show with greater accuracy the effect of any energy saving measures.

In order to adjust for weather it is necessary to know how much of the fossil energy is used for heating and how much is a steady base load. The base load can be estimated by looking at the monthly consumption of fossil energy as shown in section 7.2 or the graphs of fossil fuel against degree days as shown in section 7.3, and the rest is the energy used for space heating which varies with weather conditions.

8

CASE STUDIES

This section gives examples of buildings where energy saving measures have been implemented.

The usefulness of the Performance Index calculation is also demonstrated, both for assessing how energy efficient a building is, and as a means of evaluating the improvement in energy performance resulting from the implementation of energy saving measures.

8.1 Haggerston Swimming Pool, London Borough of Hackney

Haggerston Pool in the London Borough of Hackney is a Grade 2 listed Victorian building with a 25m swimming pool, a teaching pool, a gym, a solarium and a number of public baths.

Until 1987 the pool and building were heated by coal-fired Lancashire boilers with chain grate stokers. In the summer of 1987 these were replaced by a combination of condensing and conventional (non-condensing) boiler plant. Condensing boilers gain extra efficiency by extracting heat from water vapour in the flue gases. The new arrangement is that:

- Two condensing boilers supply heat for the pool and the pool hall radiator circuits. In milder weather these circuits are automatically controlled to work at lower temperatures which allows the full benefit of the condensing boilers to be realised
- Two conventional boilers serve the ventilation systems
- Separate gas-fired storage water heaters provide the domestic hot water so that conventional boilers can be turned off in summer.

Condensing boilers can need special flueing requirements and in this case two separate stainless steel flues for the condensing boilers rise up through the roof of the boiler house. The small quantity of condensed water forming in the flue runs back into the boiler and into the drains provided.

The main pool hall has energy efficient features in addition to the new boiler installation; for example destratification fans are used to make use of heated air collecting in the upper area of the hall, and a heat exchanger recovers heat from the pool hall and changing room ventilation systems.

Summary

It is estimated that the boilers have paid for themselves in 2 years, in line with expectations. A decision was made to replace the original coal fired boilers with a simple but effective system and the designers believe this has been achieved. The condensing boilers were chosen because they are ideally suited to the low return water temperature which results from heating pools.

There were no apparent installation or commissioning problems and the condensing boilers have now run reliably for over 6,000 and 4,000 hours respectively. Both the building operators and the public are happy with the system.

8.2 Eastern Leisure Centre, Cardiff

The Eastern Leisure Centre in Cardiff was constructed in 1982. Its main indoor sports facilities are a large main hall, four squash courts and a 25m x 12.5m pool. A study was carried out to investigate the effects of a pool cover on the energy consumption and costs of the whole sports centre.

Pool covers reduce heat loss from the pool, and also reduce evaporation rates. This in turn allows the pool hall ventilation and heating to be reduced, providing further savings. Various ways of operating the plant were investigated and the study indicated that the most effective use of a pool cover where the pool building is well insulated is:

- cover the pool as soon as practicable at the end of the day's swimming sessions
- once the cover is in place leave the ventilation fans on for a short period of around half an hour to dry out the pool surrounds
- at the end of this period turn off both the heating and the ventilation to the pool hall and restart them 15 minutes before the cover is removed the next day.

If the pool hall had been poorly insulated or if the cover had not covered the entire pool surface, it may have been necessary to run the ventilation and heating plant out of hours, preferably on a reduced setting, to avoid excessive humidity levels which could cause condensation damage to the structure.

The study also highlighted the importance of management issues regarding pool covers. Somebody must be responsible for ensuring that:

- the cover is put in place every night and removed in the morning
- the existing ventilation and heating system is appropriately adjusted to make the best use of the available savings.

In 1992/93 the annual energy cost savings were £9,340 which resulted from reduced heating and turning off the ventilation plant. This was equivalent to a reduction of 13% in the electricity consumption and 25% in the gas consumption. In other similar pools it may not be possible to turn off ventilation plant. But it is estimated that savings of nearly £5,200 would still be achieved from reduced heat losses alone. For many pools the ventilation plant would be run at low speed and an intermediate level of savings would result. The cost of an automatic pool cover for the pool is £15,000 which would be repaid in two years. This cost reduces to £7,000 for a manual cover.

Performance assessment

Floor area = 3,000 m²

	1991/92	1992/93	Savings
Fossil fuel consumption (MWh)	1890	1420	
Fossil fuel index (kWh/m²)	630	473	25%
Performance assessment	High consumption	Medium consumption	
Electricity consumption (MWh)	550	480	
Electricity index (kWh/m²)	183	160	
Performance assessment	Medium consumption	Medium consumption	13%

9

ADVICE AND HELP

9.1 The Energy Efficiency Office

The Energy Efficiency Office (EEO) is part of the Department of the Environment.

The EEO currently aims to achieve environmental and economic benefits by promoting cost effective energy efficiency measures in the industrial, commercial, domestic and public sectors of the economy by:

- Raising awareness
- Identifying and overcoming barriers to action
- Providing financial incentives where appropriate
- Regulation where necessary
- Providing technical advice.

9.2 Best Practice Programme

The EEO's Best Practice programme gathers and disseminates authoritative information on cost effective energy saving measures. The Best Practice programme for buildings is managed on behalf of the EEO by the Building Research Energy Conservation Support Unit (BRECSU) and for industry by the Energy Technology Support Unit (ETSU).

A range of publications is available under the Best Practice programme, normally free of charge. Relevant titles for sports and recreation centres are listed here.

Good Practice Guides give advice on how to implement energy saving measures. Relevant titles are:

3 Introduction to small scale combined heat and power (CHP)

55 Good housekeeping in school swimming pools

56 Saving energy in school swimming pools

129 Good housekeeping in dry sports centres - A guide for managers and staff

130 Good housekeeping in swimming pools - A guide for centre managers

Commissioning and maintenance in sports and recreation centres (to be published in 1994)

Managing energy in sports and recreation centres. A guide for those in control of sports and recreation facilities (to be published in 1994)

Energy efficiency in sports. A technology overview for general managers and local authorities (to be published in 1994).

General Information Leaflets and Reports also give advice on how to implement energy saving measures. General Information Leaflets relating to sports and recreation centres are:

1 The success of condensing boilers in non-domestic buildings. A user study.

Information on energy management is contained in these General Information Reports:

12 Organisational aspects of energy management

13 Reviewing energy management

14 Energy management of buildings including a review of some case studies.

Fuel Efficiency Booklets are working manuals which provide detailed technical guidance on specific areas of energy use in buildings and industry. Relevant booklets are:

1 Energy audits for buildings
7 Degree days
8 The economic thickness of insulation for hot pipes
9 Economic use of electricity in buildings
10 Controls and energy savings
12 Energy management and good lighting practices.

In addition, a wide range of events is organised to promote the results of the Best Practice programme. These include seminars, workshops and site visits and are targeted at different sectors and professionals.

Details of publications and events can be obtained from:

BRECSU (for buildings)
Building Research Establishment
Garston
Watford WD2 7JR
Tel: 0923 664258
Fax: 0923 664097

ETSU (for industrial sectors)
Harwell
Didcot
Oxon OX11 ORA
Tel: 0235 436747
Fax: 0235 432923.

9.3 Free Publications From the EEO

The Introduction to Energy Efficiency series. There are 13 Guides in this series, of which this is one:

Catering establishments
Entertainment buildings
Factories and warehouses
Further and higher education
Health care buildings
Hotels
Museums, galleries libraries, and churches
Offices
Post Offices, banks, building societies and agencies
Prisons, emergency buildings and courts
Schools
Shops and stores
Sports and recreation centres

Choosing an Energy Efficiency Consultant (EMAS 2)

Practical Energy Saving Guide for Smaller Businesses (ACBE 1)

The above are all available from:
Department of the Environment
Blackhorse Rd
London SE99 6TT
Tel: 081 691 9000.

The 'Energy Management' journal. Published bi-monthly and available from the EEO.
Tel: 071 276 6200.

9.4 Other EEO Programmes

Making a Corporate Commitment Campaign

The 'Making a Corporate Commitment' campaign seeks board level commitment to energy efficiency. It encourages directors to sign a Declaration of Commitment to responsible energy management, prepare a business plan for energy efficiency and ensure that it becomes an item that is considered regularly by their main board.

Publications:

Chairman's Checklist
Executive Action Plan
Energy, Environment and Profits - Six case studies on corporate commitment to energy efficiency.

Further information is available from the Campaign Offices on 071 276 4613.

Energy Management Assistance Scheme

The Energy Management Assistance Scheme may provide support for small and medium sized businesses (up to 500 employees) to employ an energy consultant. This aims to upgrade the expertise in energy efficiency among smaller companies, and tackle the capital priority barrier through financial support.

Further information can be obtained on 071 276 3787.

9.5 Sources of Free Advice and Information

Regional Energy Efficiency Officers

11 Regional Energy Efficiency Officers (REEOs) around the UK can provide copies of all the EEO's literature and give specific advice on:

- opportunities for better energy efficiency in your organisation
- technologies and management techniques you should be thinking about
- appropriate sources of specialist advice and assistance in the private sector
- EEO programmes
- regional energy managers' groups.

REEO Northern Region
Wellbar House
Gallowgate
Newcastle Upon Tyne NE1 4TD
Tel: 091 201 3343

REEO Yorkshire and Humberside
City House
New Station Street
Leeds LS1 4JD
Tel: 0532 836 376

REEO North West
Sunley Tower
Piccadilly Plaza
Manchester M1 4BA
Tel: 061 838 5335

REEO East Midlands
Cranbrook House
Cranbrook Street
Nottingham
Nottinghamshire NG1 1EY
Tel: 0602 352 292

REEO West Midlands
Five Ways Tower
Frederick Road
Birmingham B15 1SJ
Tel: 021 626 2222

REEO Eastern
Heron House
49-53 Goldington Road
Bedford MK40 3LL
Tel: 0234 276 194

REEO South West
Tollgate House
Houlton Street
Bristol BS2 9DJ
Tel: 0272 878 665

REEO South East
Charles House
Room 565
375 Kensington High St
London W14 8QH
Tel: 071 605 9160

REEO Scotland
New St Andrews House
Edinburgh
Scotland EH1 3TG
Tel: 031 244 4662

REEO Wales
Cathays Park
Cardiff
Wales CF1 1NQ
Tel: 0222 823 126

REEO Northern Ireland
Dept of Economic Development
Netherleigh House
Massey Avenue
Belfast
N Ireland BT4 2JT
Tel: 0232 529900.

9.6 Other Programmes

Energy Design Advice Scheme

The Energy Design Advice Scheme is a Department of Trade and Industry discretionary initiative aimed at improving the energy and environmental performance of the building stock by making low energy building design expertise more accessible for the energy efficient design and refurbishment of buildings. The scheme offers support, via a number of Regional Centres, to design teams or clients in the energy aspects of design of new buildings or refurbishment projects over 500m² gross area.

Further information can be obtained from the following Regional Centres:

For Scotland
Tel: 031 228 4414

For South East England
Tel: 071 916 3891

For Northern England
Tel: 0742 721 140

For Northern Ireland
Tel: 0232 364 090.

EU Programmes

Several EU programmes aimed at demonstrating energy efficiency measures and encouraging energy efficiency R&D. Details change periodically. For further information contact BRECSU for buildings and ETSU for industry.

9.7 Other Publications

Chartered Institution of Building Services Engineers (CIBSE):

CIBSE Applications Manual, AM 5:1991, Energy Audits and Surveys

CIBSE Applications Manual, AM 6:1991, Contract Energy Management

CIBSE Applications Manual, AM3, Condensing Boilers

CIBSE Applications Manual, AM8, Private and Standby Generation of Electricity

CIBSE Code for Interior Lighting (1984).

Available from:

CIBSE, 222 Balham High Rd,
Balham,
London SW12 9BS.
Tel: 081 675 5211
Fax: 081 675 5449.

Heating and Ventilating Contractors Association (HVCA):

Standard Specification for Maintenance of Building Services. Volumes 1 - 5.
1990 - 1992.

Available from:

HVCA Publications, Old Mansion House, Earmont Bridge, Cumbria,
CA10 2BX
Tel: 0768 64771.

The Sports Council:

The Handbook of Sports and Recreational Building Design

Available from:
16 Upper Woburn Place, London
WC1H OQP
Tel: 081 388 1277
Fax: 071 383 5740

9.8 Other Useful Addresses

Energy Systems Trade Association Ltd (ESTA)
PO Box 16, Stroud, Gloucestershire
GL6 9YB
Tel: 0453 886776
Fax: 0453 885226

Major Energy Users' Council
10 Audley Road
London W5 3ET
Tel: 081 997 2561/3854
Fax: 081 566 7073.

APPENDIX 1

Development of Building Performance Indices (PI)

Introduction

This section outlines how to calculate environmental and cost indices for the energy used in your building. It describes the effect of weather, building occupancy and exposure on the performance of a building, with a method to allow for these factors if required.

Adjustments of the PI for these factors produces a 'Normalised Performance Index' (NPI) which is compatible with earlier versions of this guide. For many purposes, the effect of these factors on performance indices is small enough to be ignored.

Overall performance indices

Overall performance indices provide a single measure of building performance, and can be expressed in terms of carbon dioxide (CO_2) emissions or energy cost. Overall energy indices are useful for comparing a stock of buildings or for assessing the performance of buildings with electric heating or combined heat and power (CHP). However, separate fossil fuel and electricity performance indices are more useful to assist in deciding a course of action.

To calculate overall performance indices you need the annual energy use indices as obtained in figure 6.1 and conversion factors for each of the fuels - some of which are given in figures A1.1 and A1.2. The calculation procedure is to enter the kWh/m² figure in Column 1, and multiply by the relevant conversion factors in column 2 to get either the kg of CO_2 per m² or the cost per m² in column 3.

The conversion factors shown are broadly representative of the current fuels used in sports and recreation centres, and can be used if a consistent set of factors is required. CO_2 factors, particularly for electricity, may vary from this data. Cost factors will also vary over time and as a function of use. Energy unit costs in larger buildings tend to be cheaper than for smaller supplies. You may wish to use your own costs from your own bills instead of those given here.

Overall yardsticks for CO_2 emissions or energy costs can also be calculated, by inserting yardstick energy consumptions (given in figure 6.2) into column 1. These can be compared with the actual index for your building to give an overall assessment. CO_2 and cost yardsticks calculated on the basis that the fossil fuel is gas are presented in figure A1.3.

Effect of weather on energy use

Weather changes from year to year for a given site cause variations in fossil/heating energy use of typically ±5% from the average values or ±10% in more extreme years.

Weather differences across the country cause variation in heating requirements of typically ±10% from average values and ±20% in more extreme areas.

The effect on electricity use will be small unless electricity is used for space heating, or in air conditioned buildings where the cooling energy will be higher during a warm summer.

Exposure

If a building is very exposed (on an exposed hill for example), heating energy increases by 5-10% and likewise a completely protected building may use 5-10% less. In many cases steps will have been taken on exposed buildings to improve draught sealing which will offset the increase. Electricity use is largely unaffected except in electrically heated buildings.

Hours that the building is occupied (occupancy)

Occupancy affects buildings' energy use in different ways for different systems. Heating energy in a naturally ventilated heavy building varies very little with occupancy - say 5%. If a building has a light weight structure, or is mechanically ventilated or air conditioned, the heating energy may increase in more direct proportion to the occupied hours, giving 20% variation or more from the typical occupancy.

Figure A1.1
CO_2 Performance Index Calculation

	Column 1 Annual energy use kWh/m²	Column 2 CO_2 conversion* factors kg/kWh	Column 3 Annual CO_2 emissions kg/m²
Gas		x 0.20	
Oil		x 0.29	
Coal		x 0.32	
Electricity		x 0.70	
Total CO_2 emissions per m²			

*typical 1993 emission factors

Figure A1.2
Cost Performance Index Calculation

	Column 1 Annual energy use kWh/m²	Column 2 Cost conversion factors £/kWh*	Column 3 Annual cost £/m²
Gas		x 0.014	
Oil		x 0.012	
Coal		x 0.009	
Electricity		x 0.071	
Total energy cost per m²			

*typical 1992 prices

Electricity consumption of a badly controlled building will be almost independent of the occupancy, owing to lights and services left on from early morning to last thing at night. But for a well controlled building, both lights and plant may operate in direct proportion to occupancy.

Normalised performance indices

It is possible to adjust (normalise) performance indices for weather, exposure and extended occupancy, but care is needed as incorrectly applied adjustments, or adjustments that are too simplistic, may introduce larger errors than the typical variations discussed above. For example, the effect of extended hours of use on energy consumption can easily be exaggerated, making the building performance seem better than is really the case.

Note also that while a normalised performance index is a better measure of a building's efficiency than an unnormalised index, the latter shows the building's actual performance. So a building with a low normalised performance index, but a high performance index before adjustment, is efficient, but since it is still a high user of energy, it may well offer good opportunities for cost effective energy saving.

The worksheet in figure A1.4 can be used to obtain performance indices which are normalised to standard conditions of weather, exposure and occupancy. This is useful if:

- You require normalised performance indices for compatibility with previous work
- Any of the factors cause significant errors (see above sub sections to evaluate this).

A normalised performance index based on overall CO_2 emissions or energy cost is obtained by using figure A1.1 or A1.2 and inserting the normalised performance indices for each fuel into Column 1. If more than one fuel is used for heating, calculate a separate normalised performance index for each fuel first and then use this procedure.

Performance indices - summary

- Simple performance indices are for initial energy assessments. Separate performance indices are calculated, one for fossil fuels and one for electricity use, and no adjustments are made.
- Overall performance indices, based on carbon dioxide (CO_2) or cost, are normally used when the energy supply arrangement is not typical or when a number of buildings are to be compared. Also, you may want to know the cost or the CO_2 performance for a single building.
- Normalised performance indices are used when more sensitive comparisons are required and the effect of factors such as weather and occupancy become significant. But if you choose to normalise, be aware of introducing errors.

Figure A1.3 Carbon dioxide and cost yardsticks

CO_2 Performance Assessment

Low Emissions: Less than → ← Medium Emissions: Between → ← High Emissions: Greater than

	Yardsticks in kg CO_2/m^2	Yardsticks in kg CO_2/m^2
Annual Carbon Dioxide emissions per m² of gross floor area		
Dry sports centre	95	125
Sports and recreation centre with pool	175	250
Swimming pool only	270	390
CO_2 emissions per m² of pool for swimming pool only	975	1,490

Cost Performance Assessment

Low Cost: Less than → ← Medium Cost: Between → ← High Cost: Greater than

	Yardsticks in £/m²	Yardsticks in £/m²
Annual energy cost per m² of gross floor area		
Dry sports centre	8	11
Sports and recreation centre with pool	16	22
Swimming pool only	22	32
Annual energy cost per m² of pool for swimming pool only	80	124

CO_2 and cost yardsticks are based on factors given in figures A1.1 & A1.2

Figure A1.4 Normalised Performance Indices calculation

	Fossil fuel: Gas	Fossil fuel: Oil	Fossil fuel: Other		Total of Fossil Fuels	Electricity
Total energy consumption (kWh)				(A)		
Space heating energy (kWh)				*(B)		
Non space heating energy (kWh)				A-B = (C)		
Find the degree days for the energy data year				*(D)		
Weather correction factor = 2462 ÷ D =				(E)		
Obtain the exposure factor below				*(F)		
Obtain occupancy factor for heating energy use from below				*(G)		
Annual heating energy use for standard conditions				BxExFxG = (H)		
Obtain occupancy factor for non-heating energy from below				*(K)		
Annual non-heating energy use = C x K =				(L)		
Normalised energy use = H + L =				kWh (M)		
Find floor area				m^2 (N)		
Find the Normalised Performance Indices = M ÷ N =				kWh/m^2 (P)		

* Notes:
(B) Estimation of weather-dependent heating energy use is discussed in section 7.
(D) For degree day information, see Fuel Efficiency Booklet 7 - Degree Days
Monthly degree day figures are published in 'Energy Management' (see section 9.3)
(F) Exposure factors from figure A1.5.
(G) and (K) Occupancy factors from figure A1.6.

Figure A1.5 Exposure factor

	Factor
Sheltered. The building is in a built-up area with other buildings of similar or greater height surrounding it. This would apply to most city centre locations.	1.1
Normal. The building is on level ground in urban or rural surroundings. It would be usual to have some trees or adjacent buildings.	1.0
Exposed. Coastal and hilly sites with little or no adjacent screening.	0.9

Figure A1.6 Occupancy Factors

	Factor for heating energy (G)	Factor for non-heating energy (K)
Normal building occupancy:		
Pools 17 hours per day, 7 days per week	1.00	1.00
Dry sports facilities 14 hours per day 6.5 days per week	1.00	1.00
Lightweight building Extended occupancy	0.85	0.80
Other buildings Extended occupancy	0.95	0.80

APPENDIX 2

Energy Conversion Factors

The unit of energy used in this guide is the kilowatt - hour (kWh). One kilowatt - hour is consumed by a typical one bar electrical fire in one hour. For fuels which are metered in other units, multiply the metered value by the relevant conversion factor from the following table to obtain the value in kWh.

Figure A2.1 Conversion to kWh

	kWh conversion
Light Fuel Oil	11.2 kWh/litre
Medium Fuel Oil	11.3 kWh/litre
Heavy Fuel Oil	11.4 kWh/litre
Gas Oil (35 second)	10.8 kWh/litre
Kerosene - burning oil 22 second	10.4 kWh/litre
Electricity	[Metered directly in kWh]
Natural gas	29.31 kWh/therm
Liquid Petroleum Gas (LPG) (Propane)	6.96 kWh/litre
Coal (washed shingles)	7,900 kWh/tonne
Coal (washed smalls)	7,800 kWh/tonne

Energy Efficiency Office

DEPARTMENT OF THE ENVIRONMENT

Published by the Department of the Environment. Printed in Great Britain
on environmentally friendly paper. March 1994.
93EP673.